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A DRY ROT OF THE IRISH POTATO TUBER.

BY E. MEAD WILCOX AND GEORGE K. K. LINK.

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A DRY ROT OF THE IRISH POTATO TUBER.

BY E. MEAD WILCOX AND GEORGE K. K. LINK.

INTRODUCTION.

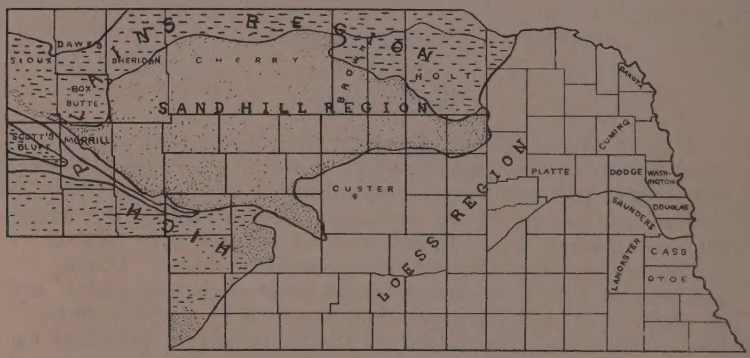
During the winter of 1907-1908, the department of Agricultural Botany received specimens, from western Nebraska, of what appeared to be a new form of dry rot of the Irish potato tuber. A preliminary survey of the situation showed clearly the importance of this new rot and steps were at once taken to take up an exhaustive investigation of this new potato disease. During the summers of 1909 and 1910, a branch laboratory was maintained at Alliance in quarters generously provided by the local authorities, to whom we are indebted for the facilities thus placed at our disposal. In this manner, we were able to study conditions at first hand and to secure results quite impossible of attainment in a laboratory located at some distance from the seat of the trouble.

In addition to the authors of the present publication, the following persons have at various times been connected with this investigation: Venus W. Pool, R. E. Stone, G. H. Coons and Ethel Fields. Much of this work would have been quite impossible without the generous support of the Legislature in providing special funds for the use of the department of Agricultural Botany, while the more technical results have been secured thru the use of the Adams fund. We wish further to express our thanks to various potato growers in the Sand Hill and High Plains regions for their interest and assistance, while to E. W. Hunt we are indebted for the earlier specimens received and to W. L. Newberry of Alliance for his cordial support of these investigations.

HISTORY AND DISTRIBUTION.

It is quite likely that this form of dry rot existed in various localities long before it attracted the attention of the potato growers or was investigated by plant pathologists. Beginning with 1895, similar or perhaps identical types of dry rot have been referred to by the pathologists of several states; tho in many cases the data given are not sufficient to enable one to clearly

establish the nature of the disease and its relationship to the one here described. This dry rot in Nebraska is largely confined to the counties included in what are known as the Sand Hill and High Plains regions.



Map showing the location of the Sand Hill and High Plains regions and indicating by name the counties each of which during 1909 produced 100,000 or more bushels of potatoes.

ECONOMIC IMPORTANCE.

Potato growing has long been a prominent part of the agriculture of northwestern Nebraska. The early "homesteaders" introduced potato culture into this region on a small scale to supply local needs. With the coming of the railroads, the industry made rapid strides and the Sand Hill and High Plains regions soon established an enviable reputation for the excellent quality of their potatoes.

The full significance of the potato crop of this part of the state may be seen from the following statistics taken from the last United States Census Report covering the crop year 1909:

TABLE 1.—*Acreage and yield of potatoes during 1909 in counties producing 100,000 or more bushels.*

Counties	Acres	Bushels
Box Butte	7,020*	303,918*
Brown	2,197*	174,862*
Cass	1,305	112,103
Cherry	2,978*	150,105*
Cuming	1,280	125,608
Custer	2,410	159,308
Dakota	1,907	142,798
Dawes	2,322*	124,782*
Dodge	1,406	121,574
Douglas	2,509	231,177
Holt	1,791	130,371
Lancaster	2,267	170,561
Morrill	1,535	107,156
Otoe	1,512	137,484
Platte	1,442	127,674
Saunders	1,363	123,315
Scott's Bluff	6,452	774,815
Sheridan	8,590*	668,309*
Sioux	2,688*	191,051*
Washington	1,251	104,168
Totals	54,225	4,181,139
Totals for Nebraska	111,151	8,117,775

* These are the counties in the Sand Hill and High Plains regions where this dry rot is most prevalent.

The losses from this dry rot have in some cases been very severe. The situation became so serious that during the spring of 1909 the Alliance Commercial Club sent the potato growers of that region a circular letter warning them against the danger of planting infected seed. This warning was based upon the fact that during the previous fall some of the largest potato buyers had refused to handle these potatoes on account of the serious losses during storage due to this dry rot. The department of Agricultural Botany thru circular letters addressed to many of the buyers and commission men handling potatoes found that during certain winters their losses from rotting of the tubers had been as high as 20 to 60 per cent.

One of the most serious losses due to dry rot is the fact that the disease forces the immediate sale of the potatoes as soon as dug. This tends to demoralize the market and places the grower at the mercy of the buyers, since he is himself afraid to store his crop and wait for better prices. Taken all in all this dry rot is perhaps the most serious potato trouble our farmers have to contend with in the Sand Hill and High Plains regions.

SYMPTOMS.

The dry rot here described is a strict tuber rot affecting mature tubers only. Neither the stems nor the young tubers are ordinarily in the least affected. Natural infection is known to occur solely thru wounds produced in the process of digging or subsequent handling. In many cases this rot secures a foothold thru wounds made by scab-producing animals of certain sorts and perhaps even thru scab spots due to fungus parasitism, tho the latter method is certainly very rare, if we may judge from the laboratory experiments. The fungus cannot invade the tuber either about the "eyes" or thru the normal lenticels.

The rotting is rather slow, and in general within four to six weeks from one-third to three-fourths of the tuber is destroyed. The epidermis of the rotted portion becomes slightly wrinkled and usually has a characteristic bluish color. On account of the rapid destruction of the underlying tissues the surface over these areas soon becomes distinctly depressed (Plate I).

The rot may make its appearance at any point on the surface of the tuber, tho more commonly perhaps at the bud end of the tuber. There is no watery degeneration of the tuber unless other organisms gain entrance, so that this is in fact a dry rot.

CAUSE.

Numerous inoculation experiments have shown that this dry rot is caused by a parasitic fungus, not previously described, for which we have proposed the name *Fusarium tuberivorum*. At the same time it has also been demonstrated that this dry rot fungus does not cause the injury to the leaves and stems often referred to as "blight" or "wilt." In other words, the present dry rot of the tuber is not connected in any manner with diseased conditions of other parts of the plant.

METHODS OF CONTROL.

The following experiments were conducted to learn if any method of treatment might be employed by which the rotting of the tubers during storage might be largely or entirely prevented. Arrangements were made to conduct these experiments in the cement potato cellar of Lincoln Davis near Gordon, Nebraska, and to him we are indebted for his enthusiastic interest and assistance in this phase of the investigation. A total of eighty-one bushels were employed in the experiment and these were divided into ten lots of about eight bushels each and treated before being placed in storage, as follows:

1. Flowers of sulfur. The tubers were rolled in this powder so that their entire surface was covered.

2. Air-slaked lime. The tubers were thoroly dusted over with this powder.

3. Lime and sulfur. The tubers were dusted over with a powder composed of three parts of air-slaked lime and one part of the flowers of sulfur.

4. Lime-sulfur wash. This was made by boiling in the usual manner five pounds of sulfur, five pounds of lime, and fifteen gallons of water. After treatment the potatoes were dried before being placed in the storage bin.

5. Formic aldehyde solution. The tubers were placed in sacks and dipped for two hours in a solution of one pint of 40 per cent formic aldehyde solution (often called "formalin") in a barrel of water. The tubers were then dried before being placed in storage.

6. Formic aldehyde vapor. The tubers were exposed to the vapors generated by twenty-three ounces of potassium permanganate placed in three pints of a 40 per cent solution of formic aldehyde (formalin) to each one thousand cubic feet of space.

7. Check. These tubers were not treated at all.

8. Check. These tubers were wounded by walking over them before they were placed in storage.

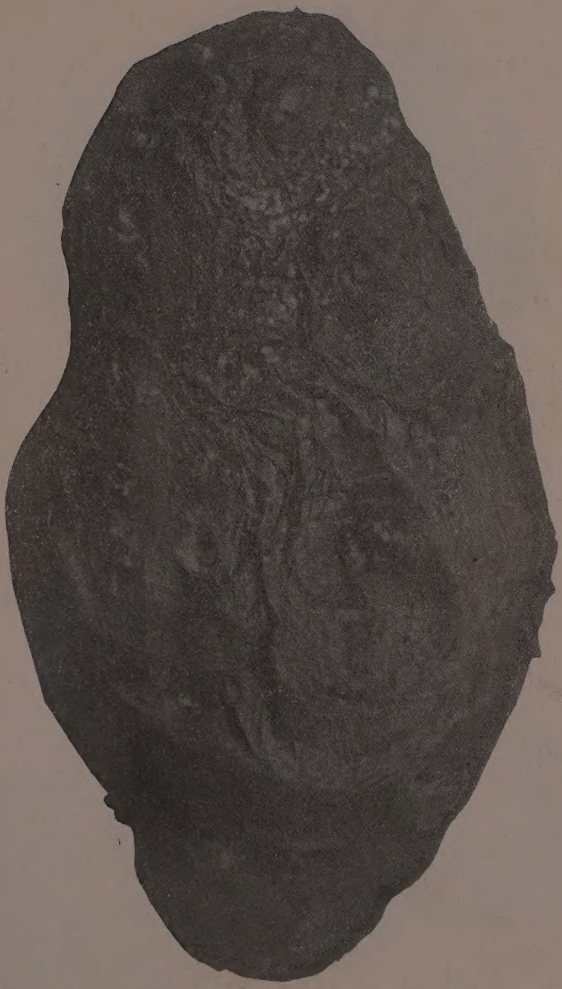
The tubers were placed in bins two feet wide and five feet long and were about three feet deep in each of these bins. The bins had previously been thoroly disinfected with formic aldehyde solution. Treatment was applied and the potatoes were stored October 1 and the counts were made the following April 25. The results are shown in Table 2.

In the first eight lots the World's Fair potato was employed, while for two of the checks smaller lots of the Blue Victor and the Early Ohio were employed.

TABLE 2.—*Result of experiments in the control of dry rot.*

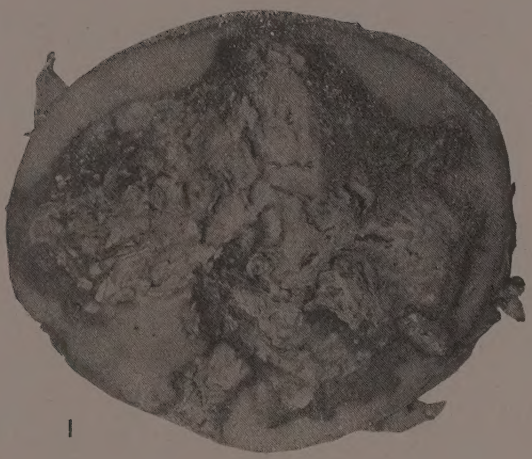
Treatment	Total number of tubers	Number rotted	Per cent rotted
1. Flowers of sulfur	1108	133	12.00
2. Lime	1393	227	16.08
3. Lime and flowers of sulfur	1208	291	24.08
4. Lime-sulfur wash	1420	45	3.16
5. Formalin dip	1221	60	4.09
6. Formalin vapor	1459	67	4.59
7. Check—not bruised	1121	182	16.23
8. Check—bruised	1262	397	31.46
9. Check—Early Ohio	1000	316	31.60
10. Check—Blue Victor	641	67	10.45

This experiment has clearly demonstrated that dry rot during storage may be held in check thru treatment of the tubers before being placed in the storage cellars. For this purpose the best results were secured thru the use of either formalin dip, formalin vapor, or the lime-sulfur wash. Not only did the tubers in these lots show a very small percentage of dry rot but the tubers themselves were in excellent condition otherwise when removed in April. The storage time, it should be remembered, employed in this experiment is longer than would ordinarily be employed by the average farmer and this gave the treatments a severe test. Under ordinary farm conditions the development of the formalin vapors is not easily secured and therefore we would particularly recommend the use of the formalin dip as the easiest method to employ and one that should give excellent results in practice.



Shows the characteristic shrivelling and wrinkling of the surface of the tuber and the fungus pustules which have broken thru the surface of the rotted area. Photographed six weeks after inoculation. Natural size.

Longitudinal section of a rotted tuber. Bacteria have here entered and caused a wet rot and brown discoloration in advance of the dry rot due to *Fusarium*. Photographed six weeks after inoculation. Natural size.



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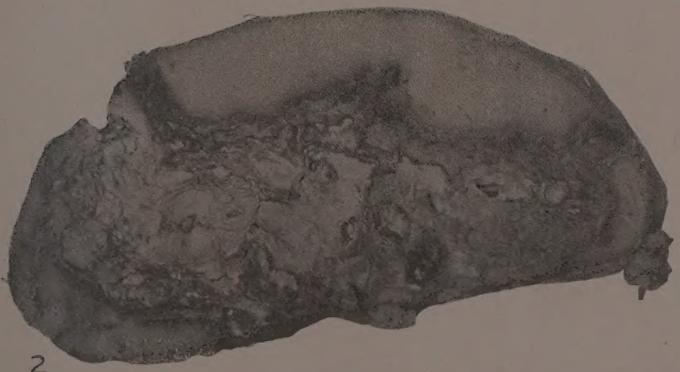

2

Photographs of tubers cut open six weeks after inoculation. This shows an extensive rotting of the tubers. No. 1 is the Pearl and No. 2 is the Burbank.